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Investigating the Viscosity Reduction of Heavy Crude Oil Using Organic Materials to Improve Oil Production and Transportation

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Abstract

Crude oil is an unprocessed petroleum product. This substance is hydrocarbon deposits and organic materials. It's utilized in several ways. It is utilized in industries, transfers, and dynamic. Heavy crude oil and bitumen are difficult to extract and treat from their resources due to their increased viscosity, limited mobility, and high carbon-to-hydrogen atomic ratios. So organic ingredients would be required to minimize crude oil viscosity. The viscosity of crude oil is a major issue for oil producers and transporters. The usefulness of waste biomaterials as viscosity reduction agents was investigated on heavy crude oils from Oman. This research collected natural materials to examine how they influenced the oil's viscosity. Date nutshell and kernel are chosen organic materials. Using waste biomaterials instead of chemical additive is more eco-friendly. This project investigated three variables (size of particles, amount of materials powder and temperature). The higher the organic matter particle size, the greater the influence on lowering crude oil viscosity. Moreover, the lowering mass of powder has higher influence on lowering the viscosity of heavy crude oil. Also, when the temperature rises, the viscosity of heavy crude oil decreases.

1. Introduction

Crude oil is a petroleum product composed of naturally occurring hydrocarbon deposits and other organic materials. (Azeez, AL-Zuhairi, and Al-Adili). Crude oil is a type of fossil fuel that is refined to make usable products like gasoline, diesel, and a wide range of certain other petrochemicals. Crude oil is the most traded commodity on the planet, and its prices fluctuate according to demand (Montes, Cortés, and Franco). In recent years, global oil demand has risen, resulting in a rise in the number of people who use crude oil for various domestic and industrial purposes. Distribution of the world's total oil reserves by oil field classification is shown in Figure1.

Oil is used in daily products like MRI machines and pacemakers, which are medical devices that have the potential to save lives. Plastics, waxes, lubricants, tars, and even asphalt for our roadways are all manufactured using petroleum refining by-products. There are four main types of crude oil: very light oil, light oil, medium oil, heavy oil. Very light oil is a crude oil with an extremely low viscosity (Subramanian, Wu, and Firoozabadi). They

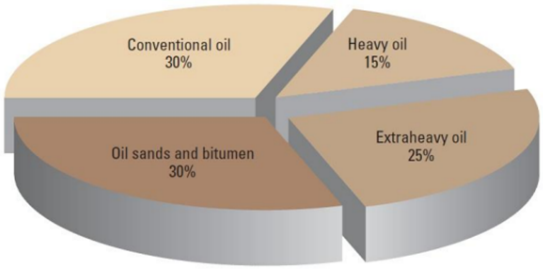

FIGURE 1. Distribution of Total World Oil Reserves

usually form due to of low density, and they flow freely at room temperature. It has a low viscosity and a low specific gravity, making it ideal and simple to transportation (Yaghi and Al-Bemani). The most common sources of this crude oil are gasoline, jet fuel, kerosene, petroleum spirit, petroleum ether, and petroleum naphtha. They also have tended to evaporate quickly. Light oil is bit heavier than the first. It can also be extracted from fuel oils of grades 1 and 2, diesel fuel oil, and local fuel oils. Medium oil is the most frequent Crude Oil kinds. This crude oil has a relatively low viscosity and a higher viscosity than light oils, a lower carbon-to-hydrogen ratio, and a relatively intermediate density (Alomair and Almusallam). Heavy oil is the heaviest crude oils, as well as Grade 3,4,5, and 6 fuel oils, fall within this category. This type of crude oil has the highest viscosity and is also the most poisonous. We can get it out of the Bitumen that is used to pave the streets (Zhao et al.). Viscosity is a measure of a fluid's (liquid or gaseous) resistance to shape change or movement of adjacent portions relative to one another. Different liquids have different viscosities and so does the gases. For example, Molasses has a greater viscosity than water (Huang et al.). that is the reason why it goes under the concept of thickness. Also, the molecules of the liquid have more viscosity because they are close to each other, this means that they have got strong bonds between them (Montes et al.). Viscosity of the fluid measure its resistance to shearing stress. Also, it is defined as the internal fluid fraction which leads to resistance to fluid flow. Viscosity is a measure of resistance to flow. The reciprocal of viscosity is called fluidity, which is a measure of how easily something flows. There are many, devices that can be used to measure the viscosity of the liquid as Saybolt viscometer apparatus (Tang). The crude oil is the major part of the dynamic in the world that's make it the necessary power for industrial and development (Sakthivel and Velusamy). In obtaining a good power system, it has many problems specific in viscosity. Here comes the necessity of this work to save money, effort and time. The viscosity of a fluid is a measure of its internal friction. A viscous fluid resists motion due to its molecular structure, which creates significant internal friction. Due to the fact that increased viscosity complicates piping transportation as well as production from the reservoir, this research concentrates on the dilution method for reducing its viscosity using a variety of organic and inorganic materials (Li et al.). The scope of this work is to Investigate the Viscosity Reduction of Heavy Crude Oil Using Organic Materials to Improve Oil Production and Transportation (Al-Dawery and Al-Shereiqi). Checking and presenting the report for performance and analysis. The viscosity of crude oil is one of the most important difficulties facing companies in the production of oil and transport it so if we reduce the viscosity of heavy crude oil, will facilitate the process of transport, reduce the cost and speed of production (Aristizábal-Fontal, Cortés, and Franco). The purpose of this study is to investigate the possibility of reducing the viscosity of heavy crude oil using organic materials in order to improve oil production and transportation. (Gudala et al.). Numerous previous studies have been conducted on this subject, but their analyses and conclusions vary due to the researchers' strategies and perspectives. (Cuijpers, Boot, and Golombok). Additionally, the materials for the experiment are readily available in local stores in Oman, such as date nutshells and kernels, and crude oil is frequently available in industrial estates. As a result, this methodology is applicable globally.

2. Methodologies

2000 ml of heavy crude oil was collected from Petroleum Development Oman company (PDO). The separation between the heavy crude oil and water by using Separatory Funnel is shown in Figure 2 (Cuijpers, Boot, and Golombok). The organic materials were collected in this stage so that they could be blended with crude oil later to see how they affected the viscosity of the heavy crude oil. Walnut shells and date kernels were employed as organic materials. The walnut shells and date kernels were

cleaned by submerging them in water for two days to wet them and separate them from the surplus materials, then removing the remaining additional materials with high pressure water to ensure they were clean. The organic materials (walnut shells and date kernels) were dried for one week utilizing solar radiation. The organic materials were then dried and solidified in a Convection oven for 48 hours at 150 degrees Celsius. Then start to be grinding two different sizes of small particles for each type of the organic materials by the strong Grinding machine firstly then two other different Grinding machines to arrive the sizes selected. The ground matter was sieved for two minutes by using Shaker sieves machine into different sizes: 250 μm, 150 μm, 75 μm and less than 75 μm Particles.

The degree of viscosity reduction (DVR percent) for heavy oil with different weight fractions of dissolution medium as a function of shear is determined using equation 1. Where μ is the viscosity of heavy oil with before (i) and after(f).

$$DVR\,\% = \frac{\mu_i - \mu_f}{\mu_i}\ X\ 100 \qquad (1)$$

The samples were prepared as shown in Table 1. The viscosity is measured by taking 40 ml from each solution, by using the Saybolt viscometer apparatus.

3. Temperature and Viscosity

In Figure 3 the temperature and viscosity are shown and it can be seen that the viscosity of heavy crude oil is 17.8 mm^3/s at 23 ^{0}C. Then when increase the temperature to 50 ^{0}C noted that viscosity of heavy crude oil reduced to 8.26 mm^3/s. Continued the viscosity to decrease to 5.9 mm3/s and 2.19 mm^3/s with increase the temperature to 100 ^{0}C and 150 ^{0}C respectively. Based on the results of the experiment it was found that there is an inverse relationship between temperature and viscosity of heavy crude oil.

4. Viscosity and Kernel Dates Particle Size

There is difference in reduction of viscosity when using different Size of particles powder. In Figure 4. the Viscosity and Kernel Dates particle size are shown. Using two different sizes of particles of Kernel Dates to reduce the viscosity of heavy crude oil. Using size of 75 μm of Kernel dates particles with Mass of powder 2 g in Volume of 50 ml of crude oil

FIGURE 2. Experimental Setup-Separatory Funnel

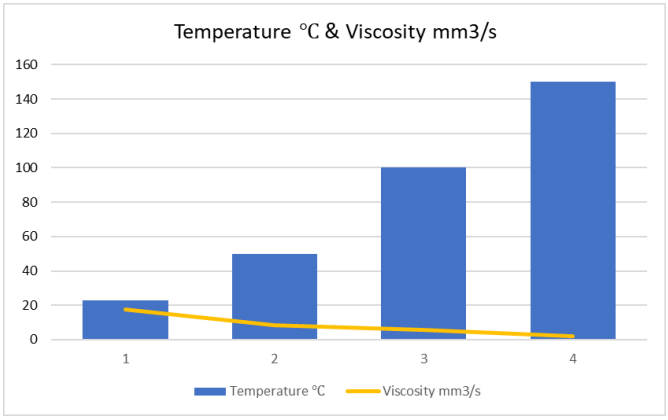

FIGURE 3. Temperature and Viscosity

at 23 0C that's reduce the viscosity to 13.85 mm3/s. Then particles of 150 μm reduce the viscosity to 9.66 mm3/s. That is mean Size of 150 μm better than 75 μm shown in Figure below.

5. Viscosity and Walnut Shell Particles Size

In Figure 5. the Viscosity and Walnut shells particles are shown. There is difference in reduction of viscosity when using different Size of particles powder. shown in Figure below. using two differ-

TABLE 1. Sample Preparation

Preparation of Samples					
Sample	Temperatures (^{0}C)	Volume of heavy crude oil	Type of Powder	Mass of Powder	Size of Particles (μm)
1 (Standard)	23, 50,100,150	50 ml	-	-	-
2	23, 50,100,150	50 ml	Kernel dates	2g	75, 150
3	23, 50,100,150	50 ml	Walnut shells	2g	75, 150

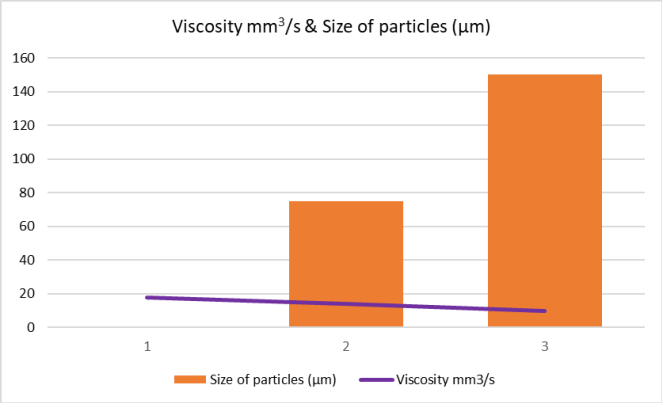

FIGURE 4. Viscosity and Kernel Dates Particle Size

ent sizes of particles of Walnut shells to reduce the viscosity of heavy crude oil. Using size of 75 μm of Walnut shells particles with Mass of powder 2 g in Volume of 50 ml of crude oil at 23 0C that's reduce the viscosity to 15.84 mm3/s. Then particles of 150 μm reduce the viscosity to 13.85 mm3/s. That is mean Size of 150 μm better than 75 μm/. Using big size of powder better than using small size.

Also using Kernel Dates powder better than using Walnut shells powder to reduce the viscosity of heavy crude oil.

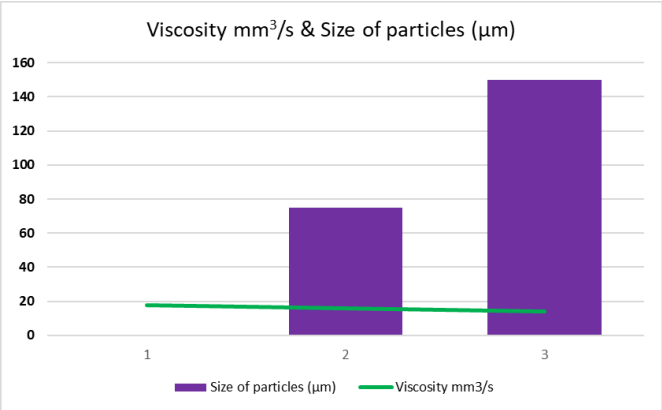

FIGURE 5. Viscosity and Walnut Shell Particles

6. Viscosity and Mass of Kernel Dates Particles

There is difference in reduction of viscosity when using different Mass of Powder. Figure 6. represents Viscosity and Mass of Kernel Dates particles. Using two different Mass of Powder of Kernel Dates to reduce the viscosity of heavy crude oil. Using mass of 4g of Kernel Dates powder with Size of particles 150 μm in Volume of 50 ml of crude oil at 23 0C that's reduce the viscosity to 11.53 mm3/s. Then mass of 8 g reduces the viscosity to 13.85 mm3/s. That is mean mass of 4 g better than 8 g shown in Figure below.

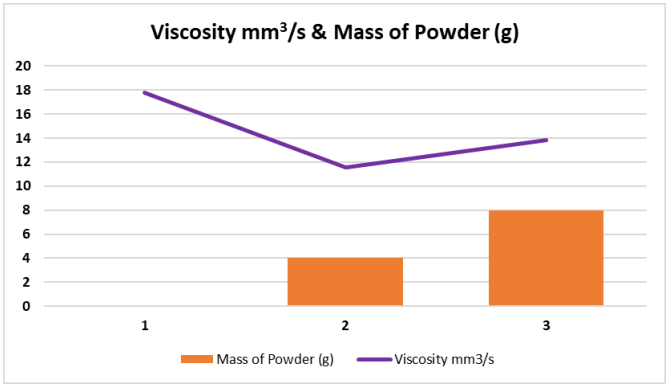

FIGURE 6. Viscosity and Mass of Kernel Dates Particles

7. Viscosity and Mass of Walnut Shell Particles

There is difference in reduction of viscosity when using different Mass of Powder. Figure 7. the Viscosity and Mass of Walnut shells particles are shown. Using two different Mass of Powder of Walnut shells to reduce the viscosity of heavy crude oil. Using mass of 4g of Walnut shells powder with Size of particles 150 μm in Volume of 50 ml of crude oil at 23 0C that's reduce the viscosity to 17.31 mm3/s. Then mass of 8 g reduces the viscosity to 19.72 mm3/s. That is mean mass of 4 g better than 8 g shown in Figure below.

Also using Kernel Dates powder better than using Walnut shells powder to reduce the viscosity of heavy crude oil.

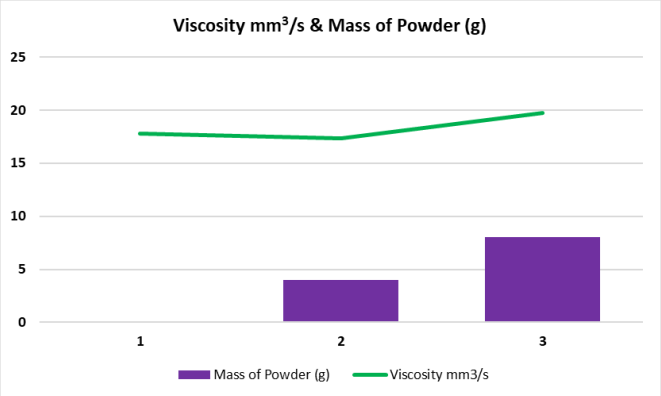

FIGURE 7. Viscosity and Mass of Walnut Shell Particles

8. Conclusion

To summarize, crude oil viscosity is one of the most significant challenges that firms face when producing oil. The vast amount of waste bio material from palm trees available in the GCC is 2 million tons per year, which is more than enough to reduce crude oil viscosity inexpensively. The organic component has an efficient effect on reducing the viscosity of crude oil, according to the results seen in the preceding chapter. There was also a clear association between the size of organic matter particles and viscosity, the larger the size of organic material particles, the greater the impact on reducing crude oil viscosity. The particles that have the size of 150 μm, was more effective than the 75 μm. Moreover, it was also found that the small mass of powder more impact will be done on reducing the viscosity of the heavy crude oil. The powder that has the mass of 4 g, was more effective than the mass of 8 g. Also using kernel dates powder better than using walnut shells powder. Beside that with increase the degree of temperature it will be increase the reducing of viscosity of the heavy crude oil. That mean temperature of 150 ^{0}c better than temperature of 50 ^{0}c and 100 ^{0}c. The aim of this research has been achieved; the viscosity of heavy crude oil reduced by using the organic materials powder and varying temperature.

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